# Thin Flexible IMM Solar Array, Phase I

Completed Technology Project (2011 - 2011)

## Project Introduction

Inverted Metamorphic (IMM) solar cells have achieved high efficiency at very low mass, but integration of the thin crystalline photovoltaic device into a flexible panel has been a challenge. The objectives of this SBIR are to mechanically package the IMM cell into a flexible laminated panel, and to assemble modular building blocks of these panels into a deployable array structure. The thin module development includes optimizing multifunctional materials for the substrate and superstrate to provide appropriate structural support as well as properties for insulation, transparency, surface conductivity, emissivity and environmental durability. The laminated IMM panels build on electrical interconnection development from parallel programs to assemble body-mounted or deployable arrays using a modular concept. The emphasis on modularity and lamination objectives will provide enhanced consistency, qualification traceability, and manufacturing technology that is amenable to process control and lowered cost. In the Phase 1 effort selects the optimized material for each layer of the substrate and superstrate, validates the materials' predicted performance, laminates IMM coupons and submodules, and tests them in basic environments, such as thermal cycling and bend radius. Phase 1 also performs the conceptual design of the roll-out array using state-of-the-art deployable array structure such as those from the selected Phase 1 subcontractor, Deployable Space Systems of Goleta, CA. The Phase 2 effort will perform a full-scale array design, including deployable structure, and build a deployable engineering ground demonstration model, including flight qualifiable materials and some active IMM thin modules. Phase 2 also includes a set of ground verification testing on coupons, submodules and modules to show durability in other harsh space environments, such as VUV, protons, plasma, atomic oxygen, and life thermal cycling.


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**Small Business Innovation Research/Small Business Tech Transfer**

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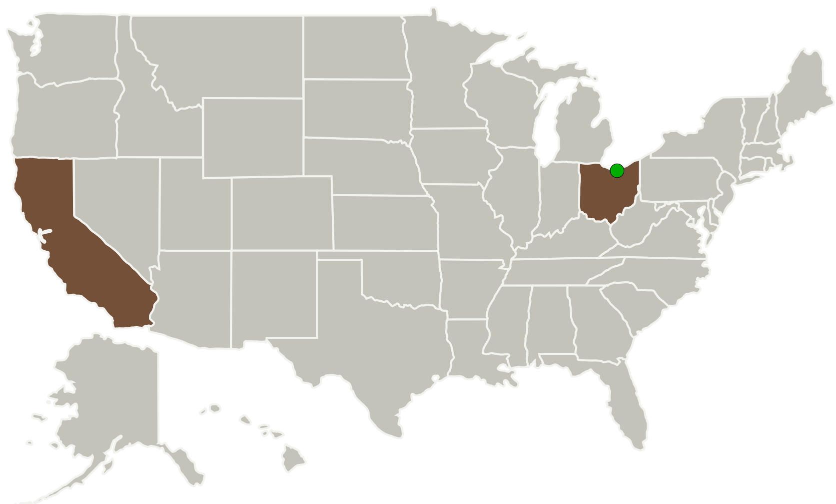
## Primary U.S. Work Locations and Key Partners



| Organizations Performing Work | Role | Type | Location |
|---|---|---|---|
| Vanguard Space Technologies, Inc | Lead Organization | Industry | San Diego, California |
| Glenn Research Center(GRC) | Supporting Organization | NASA Center | Cleveland, Ohio |

| Primary U.S. Work Locations | |
|---|---|
| California | Ohio |

## Project Transitions

**February 2011:** Project Start

## Organizational Responsibility

**Responsible Mission Directorate:**

Space Technology Mission Directorate (STMD)

**Lead Organization:**

Vanguard Space Technologies, Inc

**Responsible Program:**

Small Business Innovation Research/Small Business Tech Transfer

## Project Management

**Program Director:**

Jason L Kessler

**Program Manager:**

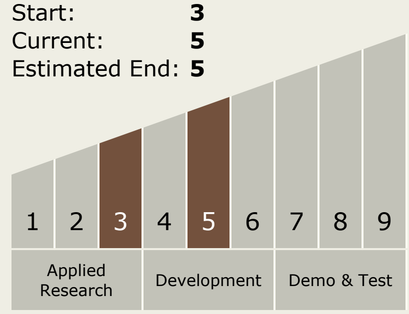
Carlos Torrez

**Principal Investigator:**

Austin Reid

## Technology Maturity (TRL)

Start: **3**
Current: **5**
Estimated End: **5**



**September 2011:** Closed out

**Closeout Summary:** Our Phase I program has addressed the possibility of applying thin-film diffractive waveplate technology to large aperture space-based telescopes for such applications as exoplanet imaging and spectral analysis. The major benefit that may be achievable with this technology is to make very large aperture, diffraction limited, space-based imaging possible at a small fraction of the cost that would be incurred with alternative methods using conventional optics including a reflective primary mirror. We have developed a point optical design that is predicted to achieve diffraction-limited imaging in the visible wavelength band over a bandwidth of ±8% of the center wavelength. The geometrical phase modulation introduced by waveplate lenses is wavelength independent – resulting in the broadband nature of these new generation components and feasibility for having near 100% diffractive efficiency over very broad range of wavelengths. Since, however, the diffraction angle depends on wavelength, the bandwidth of a diffraction-limited astronomical telescope with a flat, transmissive primary element may be limited by chromatic aberration. Finding solutions to the problem of chromatic aberrations was an important task during Phase I of our program. Luckily, unlike conventional mirrors and lenses, our novel optical components provide a myriad of opportunities to deal with the problem – we found an opportunity of increasing the diffraction limited bandwidth by near 16,000 times! While alternative diffractive optical techniques for large-aperture space-based imaging, there has been only a small effort devoted to DW lenses and mirrors for this application. In view of the critical potential advantages of this technology over the alternatives, we believe that these techniques merit further investigation for such applications.

**Closeout Documentation:**
- Final Summary Chart*(https://techport.nasa.gov/file/138586)*

## Technology Areas

**Primary:**

- TX03 Aerospace Power and Energy Storage
  - └─ TX03.1 Power Generation and Energy Conversion
    - └─ TX03.1.1 Photovoltaic

## Target Destinations

The Sun, Earth, The Moon, Mars, Others Inside the Solar System, Outside the Solar System